DETAILED ACTION

Response to Arguments

Applicant's arguments filed December 11, 2008 have been fully considered but they are not persuasive.

The Applicant argues that the specifics of the nested loop are not taught by the prior art. The Examiner provides the following statement regarding the rejection of the claims under 35 U.S.C. 103(a) with special relevance to this portion of the claimed subject matter.

Regarding forming a nested loop and the specific equations representing each datum, paragraph 47 of the current application's own specification states, "It is noted that datasets can be sampled on to planes 82, 94, 96 and 98 by a variety of methods including simple phase encoding as described above, Echo-planar imaging (EPI), and spiral imaging to generate the MR signals representative of patient 135." Therefore, the specific equation claimed and the nested loop does not hold patentable criticality to the claimed invention. The above cited references all teach either one of EPI or spiral imaging. Furthermore, Examiner notes the addition of Goto for teaching methods of magnetic resonance imaging incorporating pulse sequences which are repeated 64 to 512 times. Every time they are repeated, the phase encode gradient GP is altered to carry out phase encoding in a different way (paragraph 64). While discussed with reference to gradient echo methods, other appropriate techniques include EPI (paragraph 70). It would have been obvious to one of skill in the art to change the

phase encoding gradient with each iteration in order to properly fill k-space and acquire MR signals.

Regarding the rejection under 35 U.S.C. 101, the amendments to the claims do not overcome this rejection because the recitation does not tie the process steps to a particular machine. Furthermore, the attempted tie to an machine is provided only in the preamble and a preamble is generally not accorded any patentable weight where it merely recites the purpose of a process or the intended use of a structure, and where the body of the claim does not depend on the preamble for completeness but, instead, the process steps or structural limitations are able to stand alone. See *In re Hirao*, 535 F.2d 67, 190 USPQ 15 (CCPA 1976) and *Kropa v. Robie*, 187 F.2d 150, 152, 88 USPQ 478, 481 (CCPA 1951).

For at least the reasons stated above, the rejection from the Office Action dated September 11, 2008 still stands and is repeated below.

Claim Rejections - 35 USC § 101

The following is a quotation of 35 U.S.C. 101:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Claims 1-2, 4-20, 25, 26 and 29-31are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. The claims are directed towards data processing and computer program per se which does not constitute a

statutory process, machine, manufacture, or composition of matter. Furthermore, the claims fail to tie the process to another statutory class or identify a transformation.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1-2, 4-7, 9-10, 12, 16-19, 26 and 28-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Matsui et al. (US Patent No. 4,727,325) in view of King (US Patent No. 5,892,358), further in view of Miyazaki et al. (US Patent No.

6,068,595), and further in view of Goto (US Patent Pub. No. 2001/0041819). Matsui discloses an NMR imaging method using rotating field gradients. The gradients (see Figure 6) produce a spiral sampling of k-space as can be seen in any of Figures 5B, 8 or 10. The system includes a sequencer under the control of a central processing unit (column 4, lines 13-15). Several reconstruction methods are discussed, such as Fourier transforming information on a diameter and then subjecting that data to back projection (column 3, lines 46-49), or data from circularly sampled data is re-gridded to rectangular coordinates by 2D interpolation, and undergoes 2D Fourier transformation, to obtain a desired image (column 6, lines 28-50). Also see column 9, line 55 through column 11, line 11 for disclosure on back-projection. Also disclosed is the fact that the frequency coordinates are represented as a function of both sine and cosine functions (column 12, lines 62-68). The disclosure of Matsui is not limited to 2D and can be extended to 3D imaging, as stated at column 15, lines 35-39). While Matsui teaches a spiral trajectory, Matsui does not use an elliptical sampling of k-space.

King teaches a set of data samples acquired during an acquisition period, each of the data samples corresponding to a sampling point on the anisotropic spiral trajectory, the spacing between adjacent sampling points measured along the first k-space axis is substantially less than the spacing there between measured along the second k-space axis (*see* Abstract). This is illustrated in Figure 7 and described more in detail at column 6, lines 12-61. It would have been obvious at the time the invention was made to use an anisotropic, or elliptical, trajectory as taught by King in the system of Matsui (or any other MR system utilizing a spiral trajectory) because the anisotropic

field of view can be employed to improve spiral scan image quality (column 6, lines 14-15).

Regarding the claim language stating “forming datasets representative of an object by frequency encoding in a Z-direction of a k-space,” the Examiner reiterates the Advisory Action dated December 27, 2007. In the Advisory Action the Examiner stated, "the Cartesian coordinate system is an arbitrary labeling of the axes.” In support of this Official Notice the Examiner cites column 5, lines 2-5 of Miyazaki where it is stated, “Thus, directions in which a slice selective magnetic field gradient G_S, a phase-encoding magnetic field gradient G_E, and a readout (frequency-encoding) magnetic field gradient G_R are applied can be specified and changed arbitrarily.”

Regarding forming a nested loop and the specific equations representing each datum, paragraph 47 of the current application’s own specification states, “It is noted that datasets can be sampled on to planes 82, 94, 96 and 98 by a variety of methods including simple phase encoding as described above, Echo-planar imaging (EPI), and spiral imaging to generate the MR signals representative of patient 135.” Therefore, the specific equation claimed and the nested loop does not hold patentable criticality to the claimed invention. The above cited references all teach either one of EPI or spiral imaging. Furthermore, Examiner notes the addition of Goto for teaching methods of magnetic resonance imaging incorporating pulse sequences which are repeated 64 to 512 times. Every time they are repeated, the phase encode gradient GP is altered to carry out phase encoding in a different way (paragraph 64). While discussed with reference to gradient echo methods, other appropriate techniques include EPI

(paragraph 70). It would have been obvious to one of skill in the art to change the phase encoding gradient with each iteration in order to properly fill k-space and acquire MR signals.

Regarding claims 16 and 18, Miyazaki teaches to carry out synthesis of image data. One example of said synthesis is addition in which reconstructed image data items of a plurality of frames are added up pixel by pixel or MIP (column 5, line 56 through column 6, line 7). It would have been obvious to one having ordinary skill in the art at the time the invention was made to use MIP, as taught by Miyazaki, in the method of Matsui in order to create an image with excellent depiction ability without the loss of information of directivities (see Abstract).

Claims 1-2, 4-7 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heid (US Patent No. 6,486,670) in view of King (US Patent No. 5,892,358), further in view of Miyazaki et al. (US Patent No. 6,068,595), and further in view of Goto (US Patent Pub. No. 2001/0041819). Heid discloses a method for imaging with NMR wherein the k-space sampling proceeds along a curved path. The data is sampled on to a spiral trajectory in k-space and is then interpolated for placement onto a rectangular coordinate system. The method applies to both 2D and 3D imaging. See the section entitled “Summary of the Invention.” The method uses spiral or echo-planar imaging techniques (column 2, lines 55-62). Also see column 3, line 34 through column 4, line 5. While Heid teaches a spiral trajectory, Heid does not use an elliptical sampling of k-space.

King teaches a set of data samples acquired during an acquisition period, each of the data samples corresponding to a sampling point on the anisotropic spiral trajectory, the spacing between adjacent sampling points measured along the first k-space axis is substantially less than the spacing there between measured along the second k-space axis (*see* Abstract). This is illustrated in Figure 7 and described more in detail at column 6, lines 12-61. It would have been obvious at the time the invention was made to use an anisotropic, or elliptical, trajectory as taught by King in the system of Heid (or any other MR system utilizing a spiral trajectory) because the anisotropic field of view can be employed to improve spiral scan image quality (column 6, lines 14-15).

Regarding the claim language stating “forming datasets representative of an object by frequency encoding in a Z-direction of a k-space,” the Examiner reiterates the Advisory Action dated December 27, 2007. In the Advisory Action the Examiner stated, "the Cartesian coordinate system is an arbitrary labeling of the axes.” In support of this Official Notice the Examiner cites column 5, lines 2-5 of Miyazaki where it is stated, “Thus, directions in which a slice selective magnetic field gradient G_S, a phase-encoding magnetic field gradient G_E, and a readout (frequency-encoding) magnetic field gradient G_R are applied can be specified and changed arbitrarily.”

Regarding forming a nested loop and the specific equations representing each datum, paragraph 47 of the current application’s own specification states, “It is noted that datasets can be sampled on to planes 82, 94, 96 and 98 by a variety of methods including simple phase encoding as described above, Echo-planar imaging (EPI), and

spiral imaging to generate the MR signals representative of patient 135." Therefore, the specific equation claimed and the nested loop does not hold patentable criticality to the claimed invention. The above cited references all teach either one of EPI or spiral imaging. Furthermore, Examiner notes the addition of Goto for teaching methods of magnetic resonance imaging incorporating pulse sequences which are repeated 64 to 512 times. Every time they are repeated, the phase encode gradient GP is altered to carry out phase encoding in a different way (paragraph 64). While discussed with reference to gradient echo methods, other appropriate techniques include EPI (paragraph 70). It would have been obvious to one of skill in the art to change the phase encoding gradient with each iteration in order to properly fill k-space and acquire MR signals.

Claims 1-2, 4-7, 9-10, 14, 19-20 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brittain (US Patent No. 6,794,869) in view of King (US Patent No. 5,892,358), further in view of Miyazaki et al. (US Patent No. 6,068,595), and further in view of Goto (US Patent Pub. No. 2001/0041819). Brittain discloses a system and method for acquiring data to reconstruct MRI across a large FOV with reduced acquisition time. The phase encoding gradients for a 3D acquisition could also be positioned on concentric circles, in the shape of a spiral, in rays from the center of k-space, or in any other pattern. If a non-uniform placement is utilized, the data would be gridded in the transverse dimension(s) during reconstruction (column 13, lines 18-26). However, any 3D k-space trajectory that is uniform in the direction of table motion can

be used, including groups of planes with relative angles (column 8, lines 15-34). See column 7, lines 16-29 for a written description of Figure 5. Figure 5 demonstrates a reconstruction algorithm comprising Fourier transformation in the z-direction, followed by gridding of the data in k_x-k_y and finally Fourier transformation in the x and y-directions. The method provides stacks of images along the z-axis (column 5, lines 49-67). See column 13, lines 54-67 for discussion of contrast agents. While Brittain teaches a spiral trajectory, Brittain does not use an elliptical sampling of k-space.

King teaches a set of data samples acquired during an acquisition period, each of the data samples corresponding to a sampling point on the anisotropic spiral trajectory, the spacing between adjacent sampling points measured along the first k-space axis is substantially less than the spacing there between measured along the second k-space axis (*see* Abstract). This is illustrated in Figure 7 and described more in detail at column 6, lines 12-61. It would have been obvious at the time the invention was made to use an anisotropic, or elliptical, trajectory as taught by King in the system of Brittain (or any other MR system utilizing a spiral trajectory) because the anisotropic field of view can be employed to improve spiral scan image quality (column 6, lines 14-15).

Regarding the claim language stating “forming datasets representative of an object by frequency encoding in a Z-direction of a k-space,” the Examiner reiterates the Advisory Action dated December 27, 2007. In the Advisory Action the Examiner stated, "the Cartesian coordinate system is an arbitrary labeling of the axes.” In support of this Official Notice the Examiner cites column 5, lines 2-5 of Miyazaki where it is stated,

"Thus, directions in which a slice selective magnetic field gradient G_S, a phase-encoding magnetic field gradient G_E, and a readout (frequency-encoding) magnetic field gradient G_R are applied can be specified and changed arbitrarily."

Regarding forming a nested loop and the specific equations representing each datum, paragraph 47 of the current application's own specification states, "It is noted that datasets can be sampled on to planes 82, 94, 96 and 98 by a variety of methods including simple phase encoding as described above, Echo-planar imaging (EPI), and spiral imaging to generate the MR signals representative of patient 135." Therefore, the specific equation claimed and the nested loop does not hold patentable criticality to the claimed invention. The above cited references all teach either one of EPI or spiral imaging. Furthermore, Examiner notes the addition of Goto for teaching methods of magnetic resonance imaging incorporating pulse sequences which are repeated 64 to 512 times. Every time they are repeated, the phase encode gradient GP is altered to carry out phase encoding in a different way (paragraph 64). While discussed with reference to gradient echo methods, other appropriate techniques include EPI (paragraph 70). It would have been obvious to one of skill in the art to change the phase encoding gradient with each iteration in order to properly fill k-space and acquire MR signals.

Claims 1-2, 4-9, 11, 13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mertelmeier et al. (US Patent App. No. 2002/0175683) in view of King (US Patent No. 5,892,358), further in view of Miyazaki et al. (US Patent No.

6,068,595), and further in view of Goto (US Patent Pub. No. 2001/0041819). Mertelmeier discloses a method for fast acquisition of a MRI. The Fourier space is scanned with a raster of polar coordinates. In one reconstruction method as described, the received MR signals are subjected to a 1D Fourier transformation and are then reconstructed by means of a filtered back-projection (paragraph 5). The discussions of 2D also apply to 3D, as stated in paragraph 6. Regarding projection angles, see paragraph 36. Also see paragraphs 15-17. While Mertelmeier teaches a spiral trajectory, Mertelmeier does not use an elliptical sampling of k-space.

King teaches a set of data samples acquired during an acquisition period, each of the data samples corresponding to a sampling point on the anisotropic spiral trajectory, the spacing between adjacent sampling points measured along the first k-space axis is substantially less than the spacing there between measured along the second k-space axis (*see* Abstract). This is illustrated in Figure 7 and described more in detail at column 6, lines 12-61. It would have been obvious at the time the invention was made to use an anisotropic, or elliptical, trajectory as taught by King in the system of Mertelmeier (or any other MR system utilizing a spiral trajectory) because the anisotropic field of view can be employed to improve spiral scan image quality (column 6, lines 14-15).

Regarding the claim language stating “forming datasets representative of an object by frequency encoding in a Z-direction of a k-space,” the Examiner reiterates the Advisory Action dated December 27, 2007. In the Advisory Action the Examiner stated, "the Cartesian coordinate system is an arbitrary labeling of the axes.” In support of this

Official Notice the Examiner cites column 5, lines 2-5 of Miyazaki where it is stated, "Thus, directions in which a slice selective magnetic field gradient G_S, a phase-encoding magnetic field gradient G_E, and a readout (frequency-encoding) magnetic field gradient G_R are applied can be specified and changed arbitrarily."

Regarding forming a nested loop and the specific equations representing each datum, paragraph 47 of the current application's own specification states, "It is noted that datasets can be sampled on to planes 82, 94, 96 and 98 by a variety of methods including simple phase encoding as described above, Echo-planar imaging (EPI), and spiral imaging to generate the MR signals representative of patient 135." Therefore, the specific equation claimed and the nested loop does not hold patentable criticality to the claimed invention. The above cited references all teach either one of EPI or spiral imaging. Furthermore, Examiner notes the addition of Goto for teaching methods of magnetic resonance imaging incorporating pulse sequences which are repeated 64 to 512 times. Every time they are repeated, the phase encode gradient GP is altered to carry out phase encoding in a different way (paragraph 64). While discussed with reference to gradient echo methods, other appropriate techniques include EPI (paragraph 70). It would have been obvious to one of skill in the art to change the phase encoding gradient with each iteration in order to properly fill k-space and acquire MR signals.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAMES KISH whose telephone number is (571)272-5554. The examiner can normally be reached on 8:30 - 5:00 ~ Mon. - Fri..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Brian Casler can be reached on 571-272-4956. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BRIAN CASLER/
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JMK